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STANDARDIZATION OF SPECIFICATIONS FOR PUBLIC WORKS

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Within the last few years a great deal of study has been devoted to the standardization of specifications. While considerable advance has been made in some particulars, the subject is so broad that specifications in general have not been standardized thus far, and, from the present outlook, the standardization of specification is still in its infancy. The technical journals and periodicals are devoting considerable space, both in the news and editorial columns, to this all-important question, and if we are to judge from the apparently logical arguments for and against the various clauses in specifications, it will be some time before we will approach standard forms of specifications for the various classes of work. Before a specification is so drawn that it can be considered even to approach what might be termed a standard specification, it is not only important, but necessary, that each clause be thoroughly discussed by engineers, contractors and material manufacturers from different parts of the country in order that points of view based on practical experience in different sections of the country may be given due consideration, as local and climatic conditions are important factors in specifications for public works. A specification for a particular class of work that might be ideal in one section of the country would, in all probability, not fulfil the requirements in other sections of the country for the same class of work. It is only by a thorough and comprehensive study of existing conditions, based on the practical experience of experts trained in the various classes of public works carried on in different sections throughout the country, that any definite principles can be determined upon to govern the drawing of standard specifications. A standard specification should be based on certain definite principles, subject to minor modifications dependent upon local and climatic conditions. The standardization of specifications is therefore dependent upon a determination of these principles. This can best be accomplished through an exchange of views of not only the engi-

neers, but the representatives of the other side of the question, namely, the contractors and material manufacturers. In other words, all sides of the question and points of view should be thoroughly discussed before any definite conclusions relative to the underlying principles governing the various clauses in the specification are determined upon.

Generally speaking, the engineer is inclined to draw a specification that will safeguard him against any lack of knowledge or definite data relative to different items in the specification. To a certain degree this should be done, but it should not be so generally and universally in vogue as it is in the present day specifications for public works throughout the country. One of the great faults of many engineers is that they depend too much upon their own knowledge. The engineering field is too large and comprises too many specialties, which requires years of practical experience to master, for one man to pose as an expert in all or several branches of the profession. The medical profession is divided into specialties, and the general practitioner realizes the importance of calling in specialists, and never hesitates to do so when the occasion arises. Why not the engineer? Unfortunately, there is a tendency among many of the engineers controlling the drawing of specifications for public works to pose to their employers as "Jacks of all trades" in the profession. This attitude results in the loss of large sums of money to the public. Committees have been appointed in different sections of the country to standardize specifications, but their work has simply been of a general character, and their findings, in some instances, have not even covered local conditions, simply because expert advice was not called in. If a doctor failed to call in expert advice when occasion required, it would often result in loss of life; fortunately for the engineer it usually results in nothing more than a loss of public moneys, a subject to which very serious consideration has not been given until the last few years. There are competent specialists in every branch of the profession, and there is seldom, if ever, any excuse for lack of definite knowledge relative to standard public works, such, for instance, as the "Accepted Types of Pavements," yet by looking over the specifications in use throughout the country it will be observed that there is no standard specification.

In this particular branch of public works, however, a step in the right direction has been taken. An organization is in existence whose

membership is open to cities throughout the United States, with an associate membership open to contractors and material manufacturers. Engineers delegated by the respective cities meet once a year, and the committees on the different types of pavements present specifications which are open to discussion by the material men, the contractors and the convention-at-large. Considerable has been accomplished by this and other organizations of the kind toward the standardization of paving specifications.

Each branch of work coming under the head of Public Works covers such a large field that it is quite evident that little progress will be made toward standardizing specifications for the respective branches of work until some definite plan is formed with this object in view. General discussions have been carried on for some time, and while such discussions are of great value in so far as they represent different points of view and bring out many interesting facts, they will never result in standardizing specifications. It is time that some definite plan be formed; discussions are endless, and when carried on too long usually result in confusion. Many engineers say they do not believe in, nor see the necessity for, standard specifications for public works. It has often been said that such a thing is not practical. This is largely due to a misconception of what the standardization of specifications really means—it is only the determination of certain definite underlying principles that can be readily adapted to varying local and climatic conditions. There are, however, certain classes of work that are not affected by local and climatic conditions and that have long since passed out of the experimental stage, the specifications for which differ widely in different sections of the country. This is largely due to the fact that no concerted effort has been made to compare the specifications with a view to determining upon a standard specification embodying the most economic and scientific method of construction and selection of available materials. One of the most important questions before the engineers to-day is the standardization of specifications, and any step in this direction is a step toward efficiency and economy in public works. Engineers to-day are well equipped to formulate standard specifications. They have a more thorough knowledge of business and costs than they had a few years ago. If specialists in the different branches of the profession representing different sections of the country were assigned to standardize a speci-

fication for the particular class of work with which they are especially familiar, and discussions and suggestions were solicited from engineers, material men and contractors, an advance would be made which would ultimately result in the determination of well-defined principles governing specifications for the respective classes of public works. Contracting is every day getting more and more on a business basis. The old type of contractor is gradually disappearing, and is being supplanted by business men, engineers, and men qualified to bid under the more thorough and complete present-day specifications and the strict interpretation of the same, which has made competition keener, and consequently weeded out many of the undesirable contractors. This illustrates the importance of determining upon underlying principles that may be readily adapted to local and climatic conditions, and of drawing specifications that are designed not only to insure good work, but to secure justice and equity to both engineer and contractor. At the present day there is a great diversity of opinion among engineers as to the proper method of executing specific classes of work and where all the methods may be designed to insure good work and bring about the desired results, the costs will necessarily vary, dependent upon the requirements of the specifications or the lack of specific information contained therein. There is more than one way of climbing over a fence, but there is more time consumed and energy expended by some in accomplishing this feat than is necessary, so it might be said that there is a standard procedure that should be followed. The same is also true of the various requirements and methods pursued in the performance of certain classes of work; hence the importance of determining upon a standard method of underlying principles to govern the performance of specific classes of work embodied in the specifications. Needless to say, this will result in a more thorough understanding between the contractor and the engineer, and, consequently, lower costs and increased efficiency. Every step toward standardization of materials and workmanship reduces costs, and places public works on a more thorough business basis. A concentrated effort toward the standardization of specifications would result in a more comprehensive study of materials in use, the quality required, and the work to be performed, than has heretofore been conducted. Different engineering societies and organizations are formulating specifications for public works, but little progress will be made until the depart-

ments of public works throughout the country make it their business to co-operate with one another and with the engineering societies for this specific purpose.

The importance of standardizing specifications for public works would be self-evident if a comparison of the unit costs of specific classes of work performed under similar conditions were to be made. Unit cost records and the standardization of specifications go hand in hand, as a scientific and systematic investigation of the unit cost of work performed, methods of construction, workmanship, and materials used, must necessarily be made before any conclusions can be arrived at with a view to standardizing a specification for the particular class of work under investigation. Therefore such records should be installed in all public works departments. As a simple illustration of the desirability, both from an engineering and economic point of view, of establishing certain standards in specifications, let us take, for example, the following clauses in the specifications of different departments of public works for new granite curb set in concrete:

1. The curb shall be twenty (20) inches in depth, and from three (3) to eight (8) feet in length and of a matched width of five (5) inches on top, and at no point shall be less than four (4) inches in thickness. The bottom length shall not be more than six (6) inches shorter than the top length.
2. The curb shall be sixteen (16) inches in depth and not less than three and one-half ($3\frac{1}{2}$) feet in length, averaging on each block not less than four and one-half ($4\frac{1}{2}$) feet in length, and be five (5) inches in thickness, except as noted for bottom of curb.
3. The curb shall not be less than five (5) inches thick and twelve (12) inches in depth; the lengths may vary between three (3) and six (6) feet.
4. The curb shall not be less than sixteen (16) inches in depth, and not less than six (6) inches thick and four (4) feet long.
5. The curb shall not be less than twenty (20) inches in depth, and not less than six (6) inches thick and four (4) feet long.
6. The curb shall be nineteen (19) inches in depth, and not less than three and one-half ($3\frac{1}{2}$) feet in length, averaging on each block not less than four and one-half ($4\frac{1}{2}$) feet in length, and be five (5) inches in thickness, except as noted for bottom of curb.
7. The curb shall not be less than three (3) feet or over twelve (12) feet in length, eighteen (18) inches in depth and of a matched width of six (6) inches on top.
8. The curb shall be cut in lengths of not less than six (6) feet, with a width of seven (7) inches on top and a depth of twenty (20) inches.
9. The curb shall be six (6) inches in width on the top and twenty-two (22) inches in depth, and not less than eight (8) inches in width at the base and shall not be less than six (6) feet in length.

These are examples of the lack of co-operation between public works departments, which has resulted in more or less waste of public moneys in the municipalities where a curb of satisfactory and economic dimensions has not been used.

From these examples it is evident that it would not be very difficult to determine upon a satisfactory standard for granite curb to be used under normal conditions and set in concrete. It is rather singular that the curb with the shallowest depth, twelve (12) inches, is used in a locality having a lower temperature in winter than any of the other localities in question. It is not the intention to convey the impression that twelve (12) inches is a proper depth for a standard curb, but there is certainly no justification for a variation in depth of from twelve (12) inches to twenty-two (22) inches for granite curb to be set in concrete and used under similar conditions. It is just as important that the curb should not be too shallow as it is that it should not be too deep. If too shallow, it will not fulfil the requirements, and consequently will have to be replaced too soon to justify its use. If too deep, there will be an additional cost for the excessive depth of material. It will also be noticed that no two specifications are alike with respect to the dimensions called for.

It is evident from the above that standard specifications for staple products would be of great value to the engineer, the consumer, and the country at large, as well as to the manufacturer. If we stop to consider that a variation in depth of 2 inches in a granite curb means a difference in cost of approximately \$1,250 per mile for the extra depth of curb and concrete, which would amount to about \$625,000, without renewals, in a city having 500 miles of paved streets, it impresses one with the fact that enormous sums of money have been wasted and are being wasted to-day in public works throughout the country, which could have been, and can be, avoided through standard specifications.

Let us consider, for example, the difference in cost (about 60 cents) per lineal foot between a 16- and a 22-inch curb with a top 6 inches in width. Add to this the additional cost for concrete 6 inches thick, 6 inches in depth and 12 inches long on the back and face of the curb, which would amount to about 10 cents, and the total additional cost of a 22- over a 16-inch curb amounts to 70 cents per lineal foot, or \$6,552 per mile, or \$3,276,000 for 500

miles. These figures, of course, pertain entirely to original construction. Renewals would still further increase the additional cost of 22-inch curb over 16-inch curb in a given period of years. Now it is quite evident that, if a curb 16 inches deep will fulfil the requirements under ordinary conditions, the use of a 22-inch curb under such conditions is not justified. Nor is the use of an 18-inch granite curb justified. Where a 16-inch curb will answer the purpose, the difference in cost, as stated before, for the increased depth of 2 inches is approximately \$1,250 per mile. A mere difference of opinion does not justify this additional expenditure.

This illustration is a small matter compared with the enormous sums of money that could be saved, and with the benefit that could be derived through the standardization of specifications for materials and workmanship for public works. If, for example, the public works departments throughout the country would agree to carry the idea of standardization into the formulation, a basis of acceptance or rejection of deliveries under standard specifications of staple products, where the quality, weight and dimensions have been standardized, the carrying out of this policy would mean the gradual development of a uniform policy of accepting or rejecting all deliveries under such specification in place of the present method under which very often deliveries rejected by one department are accepted by another to the confusion of the trade. This naturally results in the public works departments paying exorbitant prices for such products, as the manufacturer must increase his price a proportionate amount to guard against the degree of uncertainty relative to the acceptance or rejection of his goods.

Standard specifications, resulting from scientific investigation and practical experience of technical experts, would be both equitable and safe, and it is quite evident that the standardization of materials would cheapen the products and act as the dominating regulator to the industries affected. The standardization of screw threads, steel rail sections, and of structural steel shapes are notable examples of this. It is also interesting to note that the agencies instrumental in establishing these standards were the United States Government, an engineering society, and a rolling mill association. This goes to show the importance of the co-operation of radically different agencies representing all phases of the situation in work of this character.

Of course there is danger of a fixed standard becoming unprogressive and falling behind the demands of the time, but, on the other hand, any changes made or suggestions relative to changes in the fixed standards would be apt to be the result of scientific investigations and practical demonstrations. There is very little doubt that the establishment of fixed standards would stimulate and encourage practical experiments based on scientific principles with a view to improving upon questionable standards. This would be a marked improvement over the arbitrary rulings and diversity of opinion of individuals, exemplified in some of the present-day specifications. The dissemination of the information obtained through such experiments would enable all departments of public works interested to know fully and accurately the results in efficiency and economy of the general practices prevailing and experiments made by every other department. This would prevent the repetition of experiments that exists at present; the repetition by one department of the mistakes made in another; and would place all information of value obtained in one department at the disposal of all the others, and thus do away with each department working independently in comparative ignorance of what is being done in other departments.

Continuous and progressive change is unavoidable in specifications for materials owing to the development of the manufacturing arts and the advancement of science. A specification must necessarily follow these developments if it is to maintain its value.

The evils that might follow from an unintelligent application of a standard specification must not be overlooked. But under our present organizations controlling public works, such evils would undoubtedly be far less than those that frequently follow from a lack of any established standards.

There cannot be any doubt about the urgent need of standard specifications for materials. It is evident that, to obtain the best results, the trade output should be standardized, as was done in the manufacture of steel rails, Portland cement, etc. Take, for example, the variation in size of quarry products, of which granite curb referred to above is a notable example, and consider the difference in the cost of shipment dependent upon the size, and the increased cost of labor at the quarry, due to the various sizes called for. The benefits to be derived through the standardization of such products would justify any expense that might be incurred through investigation

with this object in view. If we consider the broad field as to materials and workmanship, covered by specifications for public works, it is quite apparent that the benefits to be derived through the standardization of specifications in general are unquestionably of sufficient importance to justify a concerted effort on the part of the departments of public works throughout the country. The departments of public works have been suggested as a medium through which this can best be accomplished, because they can make it their business to delegate engineers to meet at an appointed time and place, probably once a year, for this specific purpose. The results of an analysis of the many methods of workmanship and dimensions of materials called for in specifications for a particular class of work carried on under similar conditions would be surprising, and would emphasize the importance of determining upon standard specifications for public works from a purely economic point of view. The economic value of adapting modern scientific business principles to any business enterprise is no longer doubted. As all classes of public works are purely a business enterprise conducted under the direction of the people for their benefit, it would seem that we have been somewhat careless in attending to our business affairs. We should co-operate with the public officials and engineers, giving them sufficient latitude to employ the necessary experts, and urge the departments of public works throughout the country to take up this question in a businesslike manner, and to leave no stone unturned until the desired result has been attained. Too much emphasis cannot be laid upon the fact that, in order to keep pace with the constantly changing trade conditions and advancement of science, from time to time, all established standards must be subject to modifications. Therefore, standardization must be a continuing principle. Any association or organization established for this purpose should be permanent and should be the medium through which all necessary modifications in public works specifications are made.

The American Society for Testing Materials and the American Society of Municipal Improvements have made some progress toward the standardization of specifications. But all the work done through these societies has been purely voluntary on the part of the engineers, and, consequently, lack of time through press of business seriously interferes with the work. The importance of the situation, however, will be observed from the following extract of the report of the Com-

mittee for Standard Sewer Specifications appointed by the American Society of Municipal Improvements:

Several meetings of your committee have been held and substantial progress has been made, but its work has not yet advanced to the point where any portion of it can be submitted to the society for adoption.

Your committee realizes that sewer specifications, in order to be worthy of general confidence and adoption as standard, and to insure as general unanimity of opinion as possible as to their various provisions, must cover a wide range of conditions and must be in general harmony with the conclusions of committees of other technical societies and associations which are working upon similar problems.

No standard specification for sewer construction which has been generally recognized or adopted as such, has, up to the present time, been produced, and the specifications in use by even the largest and most important municipalities vary widely in many of their most important provisions. Difference in local conditions would, no doubt, warrant special provisions in regard to some of the more important details, but there would seem to be little reason why, in the most important particulars, standard requirements may not be applicable.

Materials of construction of acceptable quality are usually available.

The functions to be performed by the finished structures are substantially the same, and if the structures are designed to be permanent, as economy and expediency would generally require, the standard of excellence in the materials and workmanship employed may well be uniform.

Specifications for sewers of extraordinary size and special design will generally require addenda supplementing the standard specifications to meet the requirements in each particular case, while for pipe and masonry sewers of ordinary size, standard forms should ordinarily suffice.

The work done by the committees of these societies is done at their own expense and in their own time, and consequently cannot be as thorough and cannot bring about the desired results as quickly as if the work were a part of the business of the public works departments. It is not only a part of the business of such departments, but a very important part of their business, if economy and efficiency in public works is desired. It is needless to say that all public works departments should, and are striving to, conduct their business along these lines. Then why not make the standardization of specifications a business proposition, by making it part of the engineers' work? The expense incurred would be infinitesimal compared with the benefits derived. The highest plane of economy and efficiency in public works can only be attained through the standardization of specifications. Methods of construction, workmanship, and materials are constantly undergoing changes. A permanent association for the

standardization of specifications would enable all the public works departments throughout the country to keep abreast of the times and avail themselves of the most modern and up-to-date specifications based upon scientific investigations of trained experts in the various branches of the engineering profession. Of course too much emphasis cannot be laid on the importance of an organization of this kind co-operating with all other organizations and technical societies engaged in similar work, as the scope of the work covers such a broad field that every effort should be made to make it as thorough as possible.

The whole country is alive to the importance of standard specifications and the benefits to be derived from the same. All that seems to be lacking is a well-conceived plan to bring about the desired results. Some plan along the lines of the one suggested would be feasible, and has a distinct advantage in controlling such a large proportion of the available talent, necessary funds and data. Another feature, and the dominating one, is that the undertaking would be a business proposition conducted along business lines, with a definite object in view, namely, the standardization of specifications for public works. Such a movement would undoubtedly receive the hearty co-operation of the American Society of Civil Engineers and other technical and engineering societies throughout the country. As it is essential to have some definite plan to start a work of such importance and magnitude, it is suggested that the public works departments co-operate with the American Society of Civil Engineers, with a view to devising ways and means best adapted to the carrying out of a plan along the lines of the one proposed, and thus bring about the desired results as speedily as circumstances will permit.